

### **REMARKS/ARGUMENTS**

The courteous telephone interview granted applicants' undersigned attorney by Examiner Tang on July 9, 2007 is hereby respectfully acknowledged. Examiner Tang requested that the arguments be presented in a formal response. An interview is requested with the Examiner after she has had an opportunity to review the arguments.

Claims 1, 4, 8, 9, 11, 14, 15, 19, 20, 22, 23, 25, 27, 29, 31, and 33-47 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Publication No. 2002/0097726 (Garcia-Luna-Aceves et al.) in view of U.S. Patent Application Publication No. 2002/0073224 (Varma et al.). Applicant notes that Garcia-Luna-Aceves et al. was filed after the filing date of Applicant's invention and that only the subject matter contained in related provisional application No. 60/240,654, filed October 10, 2000 is prior art.

Applicants' respectfully submit that neither Garcia-Luan-Aceves et al. nor Varma et al., either alone or in combination, show or suggest a method or apparatus for estimating worst-case delay, as set forth in the claims. Reconsideration of the rejections is therefore requested.

In the Response to Arguments section at pages 2-4 of the final Office Action dated May 18, 2007, the Examiner simply copied Applicant's arguments. At the top of page 5, the Examiner provided the following response:

“[T]he amended language does not apply to what applicant intended to claim. And it is being interpreted that the worst case is calculated by dividing the burst parameter by a bandwidth that is assigned/allocated to the queue, and the bandwidth which is greater or equal to the associated rate, which is still reads on by Varma's references. Further Garcia disclosed wherein the queue is allotted a share of an output link capacity, said share exceeding the associated rate (refer to 0106 or 0057).”

In claim 1, for example, the periodic worst-case delay is calculated by dividing the burst parameter by a share of output link bandwidth allotted to the queue and that the

share of output link bandwidth is greater than or equal to the associated rate. As described in the specification, the associated rate is a specified bandwidth, which may be, for example, a negotiated rate agreed to by a customer sending traffic data. This value is used to calculate the burst-rate traffic profile and a burst parameter. After traffic is queued, it is sent out of the router on an output link. The output link has an associated output link bandwidth. Multiple queues can share an output link, with each queue allotted a share of the output link bandwidth. It is this share of the output link bandwidth that is used to calculate the worst-case delay. The Examiner has not explained why "the amended language does not apply to what applicant intended to claim" (see top of page 5 of the final Office action). In the Response to Arguments, the Examiner refers to paragraphs [0106] and [0057] of Garcia-Luan-Aceves et al. as disclosing that a queue is allotted a share of an output link capacity. These paragraphs simply describe how extra bandwidth can be allocated on a per-class basis and that a link scheduler maintains only the total allocated bandwidth for real time flows on a link. Claim 1, however, requires that a periodic worst-case delay is calculated by dividing a burst parameter by a share of output link bandwidth allotted to a queue and that the share of output link bandwidth is greater than or equal to an associated rate. Furthermore, the Examiner has not addressed any of the other arguments presented in response to the Examiner's rejections. These arguments are set forth below.

The cited references do not show or suggest collecting traffic data a queue associated with a traffic aggregate over a time interval, the traffic data comprising packet size and arrival time of each packet arriving at the queue during the time interval, as set forth in claim 1.

Garcia-Luan-Aceves et al. disclose a method for maintaining reservation state in a network router. The Examiner cites paragraphs [0016], [0054], [0066], and [0089] with respect to collecting traffic comprising packet size and arrival time over a time interval. As noted at paragraph [0054], routers only know the rates of incoming traffic on the links and the rates of outgoing traffic for each destination, they do not maintain information on the rates of each flow. Paragraph [0016] notes that the invention provides techniques that

replace per-flow state and per-flow processing with mechanisms whose complexity is determined by the network parameters. Paragraph [0066] refers to how classes are based on packet sizes. A shaper is used to shape flows to a form  $(L, \rho)$ , where  $L$  is the maximum size of any packet of the flow and  $\rho$  is the rate of the flow. Paragraph [0089] describes classes based on burst-drain-times, which is the time to transmit one bucket at the rate of the flow. The Examiner has failed to point to any teaching of collecting traffic data at a queue of a router, the queue associated with a traffic aggregate over a time interval, and the traffic data comprising packet size and arrival time of each packet arriving at the queue during the time interval, as required by claim 1. Applicants further note that at page 6 the Examiner also states that Garcia does not expressly indicate that the arrival time of traffic is collected.

Varma et al. describe a method for determining burstiness of a traffic source. The Examiner cites paragraph [0067] with regard to collected traffic data. Paragraph [0067] describes how active periods are determined by traversing a sequence of frames and computing the queue size after each frame arrives. Varma et al. do not collect packet size and arrival time for each packet. In contrast, Varma et al. compute a queue size at certain periods to determine active periods of a stream.

The cited references also do not show or suggest calculating a burst-rate traffic profile responsive to the traffic data collected at the queue over the time interval and a specified bandwidth and calculating a burst parameter based on the specified bandwidth, as set forth in claim 1.

With regard to calculating a burst-rate traffic profile responsive to the traffic data collected at the associated rate, the Examiner cites paragraph [0063] of Garcia-Luan-Aceves. This section of the Garcia-Luan-Aceves et al. patent defines a delay for the flow as the waiting time at the shaper at the ingress node and the propagation delays of the links on the flow's path (see equation in paragraph [0063]). The equation of Garcia-Luan-Aceves et al. include a maximum burst size  $\sigma$  (not a burst parameter based on a specified bandwidth for the traffic aggregate, as required by claim 1) divided by an average rate of flow  $\rho$  of incoming traffic (rather than a specified bandwidth for a traffic

aggregate, as set forth in the claims). The average rate of flow used by Garcia-Luan-Aceves et al. masks extreme high values (e.g., occasional large delays), which can be very annoying to a typical user.

Furthermore, the cited references do not show or suggest calculating a periodic worst-case delay for a burst-rate profile by dividing the burst parameter by a share of output link bandwidth allotted to a queue, wherein the share of output link bandwidth is greater than or equal to the associated rate, as set forth in claim 1.

The Examiner cites the same equation and parameters from Garcia-Luan-Aceves et al. for calculating a periodic worst-case delay as were cited for calculating a burst-rate traffic profile (paragraph [0063]). Garcia-Luan-Aceves et al. simply show a flow delay calculated using a maximum burst size of flow of incoming traffic divided by the average rate of the flow of the incoming traffic (see, paragraphs [0054], [0063], and Fig. 1). Thus, there is no burst parameter calculated based on a specified bandwidth (Garcia-Luan-Aceves et al. instead use a maximum burst size as burst parameter), divided by a share of output link bandwidth allotted to a queue (Garcia-Luan-Aceves et al. use an average rate of flow of incoming traffic). Applicants further note that on the bottom of page 6 of the Office Action, the Examiner states that Garcia-Luan-Aceves et al. do not expressly indicate calculating a periodic worst-case delay for the burst-rate traffic profile by dividing a burst parameter by an allocated bandwidth associated with the queue.

The Examiner cites paragraph [0015] of Varma et al. with regard to calculating a delay. Paragraph [0015] describes a latency rate model in which the worst case delay is determined by dividing the queue size by the average source rate and adding the latency at each scheduler (see, also paragraphs [0010]-[0013]). Varma et al. do not teach calculating a periodic worst-case delay by dividing a burst parameter calculated based on a specified bandwidth for traffic aggregate at a queue, by a share of output link bandwidth allotted to the queue. In contrast to applicant's invention, Varma et al. divide a queue size by an average source rate at a server. As noted above averaging rate of flow masks extreme high values (e.g., occasional large delays). Claim 1 specifically refers to calculations which use both a share of output link bandwidth allotted to a queue and an

associated rate (specified bandwidth), which are two distinct values. The equations cited by the Examiner in both references use only an average rate of flow of incoming traffic. Moreover, neither reference shows or suggests a share of output link bandwidth (used to calculate the worst-case delay) that is greater than or equal to an associated rate (specified for a traffic aggregate and used in calculating a burst parameter).

The cited references provide information only about current conditions. They do not predict how the system will perform under different traffic conditions or with a different allocation of resources (e.g., change in specified bandwidth or change in share of output link bandwidth allotted to a queue). Applicant's invention, as set forth in the claims, is particularly advantageous in that it allows for the worst-case delay to be analyzed under hypothetical conditions such as different output link bandwidth allocations. The method and apparatus can be used to estimate the effect of an increase in bursty traffic on delay and can be used to tell how much additional bandwidth is needed to achieve a certain reduction in delay with existing traffic. For example, a service provider can use the calculated worst-case delay to determine how much additional bandwidth to allocate to a queue to achieve a desired decrease in delay. In another example, the associated rate can be set to a hypothetical negotiated rate and similar calculations performed.

Accordingly, claim 1 is submitted as patentable over Garcia-Luna-Aceves et al. and Varma et al.

Claims 4, 7, 8, and 33-41, depending either directly or indirectly from claim 1, are submitted as patentable for at least the same reasons as claim 1.

With regard to claims 4 and 37, Garcia-Luna-Aceves et al. do not show or suggest a negotiated rate agreed to by a customer sending the traffic data or a maximum average bandwidth specified in a service level agreement. As discussed above, both Garcia-Luna-Aceves et al. and Varma et al. use an average rate of incoming flow. In rejecting these claims, the Examiner cites paragraph [0053] of the Garcia-Luna-Aceves et al. patent application. This paragraph describes token-bucket parameters for input flow, which include a maximum burst size and an average rate of flow. Furthermore, if the Examiner

is using this value as the associated rate, as defined in claim 1, then the equation using these parameters in paragraph [0063] would teach away from applicants' invention, in which the worst-case delay is calculated using a share of output link bandwidth allotted to the queue and not the associated rate, which is instead used in calculating the burst parameter.

Claims 40 and 41 are further submitted as patentable over the cited references which do not show or suggest calculating error of data by comparing collected data to the burst-rate traffic profile. In rejecting these claims the Examiner refers to paragraph [0089] of the Garcia-Luna-Aceves et al. patent. This paragraph describes how flows with the same burst-drain-times can be merged without changing the burst-drain-time of the resulting flows. There is no discussion of calculating error of data or comparing collected data to a burst-rate traffic profile.

Claim 9 is directed to a method of estimating worst-case queuing delay along a path. The method includes collecting a rate parameter and a burst parameter. As previously discussed, neither Garcia-Luna-Aceves et al. nor Varma et al. show or suggest calculating a periodic worst-case delay, as set forth in the claims. Moreover, these references do not teach adding up a periodic worst-case delay associated with routers along a path, as required by claim 9. The Examiner refers to  $\tau_{ik}$  of Garcia-Luan-Aceves et al. Variable  $\tau_{ik}$  is the propagation delay of links (i, k) along a path of flow. This is added to the waiting time at the shaper at the ingress node. Garcia-Luna-Aceves et al. do not add up calculated worst-case delays associated with routers along a path. Instead Garcia-Luna-Aceves et al. add propagation delay of links along a path to a calculated waiting time at a shaper at an ingress node (see paragraph [0063]).

Accordingly, claim 9 is submitted as nonobvious over the cited references.

Claim 11 specifies calculating a burst parameter and a burst-rate traffic profile, claims 14 and 27 require code that causes a processor to calculate a burst parameter and code that causes the processor to calculate a burst-rate traffic profile, and claim 23 specifies means for calculating a burst parameter for the collected traffic and means for calculating a burst-rate traffic profile. Claims 12, 14, 23, and 27, and the claims

depending therefrom, are submitted as patentable for at least the reasons discussed above with respect to claim 1.

Claims 20 and 29 specify code that causes the processor to receive burst and rate traffic parameters. Claim 25 requires means for periodically collecting rate and burst traffic parameters. Claim 31 specifies that the periodic worst-case delay is based on a burst parameter and a rate parameter. Claims 20, 25, 29, and 31, and the claims depending therefrom, are submitted as patentable for the reasons previously discussed with respect to claim 9.

For the foregoing reasons, applicant believes that all of the pending claims are in condition for allowance and should be passed to issue. If the Examiner feels that a telephone conference would in any way expedite the prosecution of the application, please do not hesitate to call the undersigned at (408) 399-5608.

Respectfully submitted,



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